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(71) Applicant *(for all designated States except US)*: **ZEOCHEM AG** [CH/CH]; Seestrasse 108, CH-8707 Uetikon am See (CH).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: **HAWES, Peter** [GB/CH]; Schoorenstrasse 9, CH-8713 Uerikon (CH). **SCHEUBLE, Andreas** [CH/CH]; Geisshalden, CH-8706 Meilen (CH). **KLEEB, Beat** [CH/CH]; Weissenrainstrasse 37, CH-8707 Uetikon (CH). **PFENNINGER, Armin** [CH/CH]; Tiefenbrunnenweg 7, CH-8707 Uetikon (CH).

(74) Agent: **E. BLUM & CO.**; Vorderberg 11, CH-8044 Zürich (CH).

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(54) Title: METHOD FOR SULFUR COMPOUNDS REMOVAL FROM CONTAMINATED GAS AND LIQUID STREAMS

(57) **Abstract:** Abstract Described is a desorption process and a process for producing a catalytically deactivated formed zeolitic adsorbent, whereby both processes are suitable to improve the lifetime of a formed zeolitic adsorbant in the removal of sulfur compounds from sulfur contaminated gas and liquid feed streams. The adsorbent is in particular a synthetic 13X or LSX faujasite with a silica to alumina ratio from 1.9 : 1.0 to about 3.0 : 1.0. The cations of the faujasite include alkali and alkaline earth metals. The formed zeolite mixture is preferably catalytically deactivated due to a phosphate treatment. The desorption is carried out thermally, wherein the heat treatment is done at different temperature stages to avoid decomposition of the organic sulfur compounds.

Method for sulfur compounds removal from contaminated gas and liquid streams

5   **Technical Field**

The present invention relates to a novel adsorption process for removal of sulfur compounds, including mercaptans, sulfides, disulfides, thiophenes and
10   thiophanes from liquid and gas feed streams, and more particularly, an adsorption process for purification of hydrocarbons, petroleum distillates, natural gas and natural gas liquids, associated and refinery gases. The process is characterized in using a modified faujasite
15   type zeolite adsorbent and/or a dedicated way to regenerate the adsorbent to avoid decomposition and coking of the adsorbed sulfur compounds.

20   **Background Art**

Most organo-sulfur compounds possess a strong and unpleasant odor. Thus, gases and liquids, which contain even a very small amount of these compounds, have a
25   bad smell. For some applications, as for city gas, this is a desired side effect to avoid hazardous situations, but in most cases, sulfur compounds are troublesome impurities that need to be removed. Owing to this problem, the technology of removing these substances is conven-
30   tionally termed as "sweetening" or deodorization. These sulfur-contaminated compounds are also corrosive, causing damage to technological equipment and transportation systems. Further, practically all sulfur-contaminated compounds are irreversible poisons for many catalysts used
35   in chemical processes. Therefore, such commercially important processes as natural gas steam reforming, individual hydrocarbons and petroleum distillate isomerisa-

tion, hydrogenation, etc. require practically complete removal of the many sulfur compounds from the process feed before catalysis. Finally, it should be mentioned, that the full oxidation of the organic sulfur compounds

5   leads to sulfur dioxide and sulfur trioxide, whose formation needs to be minimized for ecological reasons.

Removal of sulfur containing compounds is normally done in two steps. In a first stage, the amine treatment removes hydrogen sulfide from the system. Some

10 mercaptans, part of carbon oxysulfide and of carbon dioxide may also be removed in this step. This process is related to absorption. The second step is an adsorption of organic sulfur compounds, especially mercaptans, sulfides, thiophenes, thiophanes and disulfides.
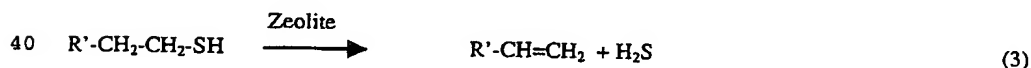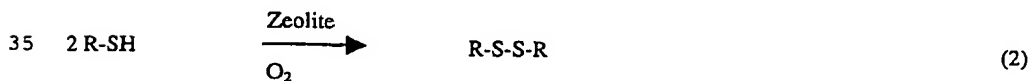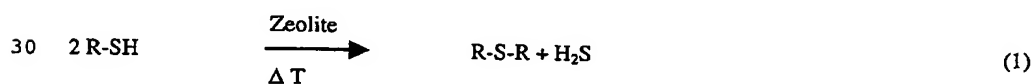
15   Adsorption of sulfur-contaminated compounds is the most common method for removal of these sulfur compounds, because of the high performance and relatively low capital and operational costs. Numerous processes and adsorbents have been developed for the removal of organic

20 sulfur compounds and hydrogen sulfide, carbon oxysulfide and carbon disulfide, from gases and liquids.

The most widely used physical adsorbents for these sulfur compounds are synthetic zeolites or molecular sieves. For example, US 2,882,243 and US 2,882,244

25 disclose an enhanced adsorption capacity of molecular sieves NaA, CaA, and MgA for hydrogen sulfide at ambient temperatures. US 3,760,029 discloses the use of synthetic faujasites as an adsorbent for dimethyl disulfide removal from n-alkanes. US 3,816,975, US 4,540,842 and US

30 4,795,545 disclose the use of standard molecular sieve 13X as a sulfur adsorbent for the purification of liquid hydrocarbon feedstocks. For removal of carbonyl sulfide, mercaptans, and other sulfur compounds from liquid n-alkanes, US 4,098,684 discloses the use of combined beds

35 of molecular sieves 13X and 4A. EP 0 781 832 discloses zeolites of types A, X, Y and MFI as adsorbents for hy-

drogen sulfide and tetrahydrothiophene in natural gas
feed streams.

Regeneration of these molecular sieves is
possible at elevated temperatures. To facilitate regen-
5   eration of the molecular sieves by removing the sulfur
compounds adsorbed, the use of cation exchanged forms of
zeolite types A, X, Y have been proposed due to their
catalytic activity in the reduction or oxidation reaction
of sulfur compounds at the regeneration stage. For in-
10 stance, US 4,358,297 discloses regeneration of the ad-
sorbent using hydrogen or a hydrogen-contaminated stream
at elevated temperatures, 200 - 650°C, resulting in con-
version of the organo-sulfur compounds to hydrogen sul-
fide. US 5,843,300 discloses a regenerable adsorbent for
15 gasoline purification that comprised a standard zeolite X
impregnated with up to 1% by weight zero valent platinum
or palladium. This noble metal component provides hydro-
genation of the adsorbed organic sulfur compounds on the
course of the adsorbent regeneration. However, the intro-
20 duction of noble metals into the adsorbent composition
substantially increases the cost of the adsorbent.

During adsorption and especially during de-
sorption, the mercaptans undergo chemical transforma-
tions. The mercaptans may form sulfides, disulfides or
25 alkenes and hydrogen sulfide according equation (1), (2)
and (3). This phenomenon is described in detail in K.-H.
Bergk, F. Wolf, Z. Chem. 1974, 14(9), 344-349.

$$30 \quad 2\,R\text{-}SH \quad \xrightarrow[\Delta T]{\text{Zeolite}} \quad R\text{-}S\text{-}R + H_2S \qquad (1)$$

$$35 \quad 2\,R\text{-}SH \quad \xrightarrow[O_2]{\text{Zeolite}} \quad R\text{-}S\text{-}S\text{-}R \qquad (2)$$

$$40 \quad R'\text{-}CH_2\text{-}CH_2\text{-}SH \quad \xrightarrow{\text{Zeolite}} \quad R'\text{-}CH=CH_2 + H_2S \qquad (3)$$

4

        The alkenes are unstable under the regenera-
tion conditions and tend to oligomerise and ultimately
5 will lead to coke formation in the zeolite pores. L.N.
Gimadeev et al., Gazov Prom-st **1985**, 9, p. 34 describe
that at a regeneration temperature of 350°C after a few
adsorption cycles, the coke formation will reduce the ad-
sorption capacity dramatically.
10   Ziolek et al., Pr. Nauk. Inst. Chem. Technol.
Nafty Weg **1996**, 55(8), 67-73 discuss the influence of
Bronsted acid, Lewis acid and/or basic sites on the zeo-
lite surface to the catalytic decomposition of mercaptans
during regeneration. However, they fail to teach on how
15 to deactivate such centers on a zeolite.
        All these molecular sieve adsorbents can work
at ambient temperature and have a substantial capacity
for removal of sulfur compounds at relatively high con-
centrations. While all these products have been useful
20 for gas and liquid stream purification of sulfur-
contaminated compounds, they need special arrangements to
get full regeneration.
        It is a main aspect of the present invention
to enhance the lifetime of zeolitic adsorbents, in par-
25 ticular by providing improved adsorbents and processes
which do not have the disadvantages of the regeneration
mentioned above. Accordingly, it is an aspect of the in-
vention to provide an adsorbent and a process for purifi-
cation of sulfur-contaminated feed streams with improved
30 regeneration capabilities.
        It is a further aspect of the invention to
provide a low cost adsorbent for sulfur compounds.
        It is a further aspect of the invention to
provide an improved process for regeneration of the mo-
35 lecular sieve.
        It is still a further aspect of the invention
to disclose an adsorbent with capability to purify feed

streams of practically all organo-sulfur compounds, in-
cluding thiols (mercaptans), sulfides, disulfides, thio-
phenes, thiophanes, etc. as well as hydrogen sulfide,
carbon oxysulfide, and carbon disulfide, individually or
in combination thereof.

        These and further aspects of the invention
will be apparent from the description of the invention,
and in particular of the preferred embodiments thereof.

Disclosure of the Invention

        Typical sour natural gas treatment consists
of the following steps.

        1. Slug catching to separate liquid and gas
phases

        2. Amine treatment to remove hydrogen sul-
fide. Some mercaptans and carbon dioxide and carbon oxy-
sulfide may also be removed in this step.

        3. Treatment with an adsorbent, e.g. molecu-
lar sieve to remove mercaptans and moisture

        4. Cryogenic treatment to recover hydrocar-
bons.

        The present invention concentrates on step 3.
above. It provides an improved adsorption/desorption
step, whereby this improvement is obtained by

        (i)   a specific adsorbent or

        (ii) a process for removing sulfur compounds
from sulfur contaminated gas and liquid streams which ex-
hibits enhanced adsorption capacity and easier regenera-
tion over an enhanced number of cycles, over a broad
range of sulfur compound concentrations and over a broad
range of temperatures, or, preferably,

        (iii) a combination of (i) and (ii).

        The inventive adsorbent comprises faujasites,
in particular synthetic zeolite 13X or LSX faujasites,
wherein the silica to alumina ratio is from about 1.9 :

1.0 to about 3.0 : 1.0, preferably from about 2.0 : 1.0
to about 2.5 : 1.0, and wherein exchangeable cations are
introduced into the synthetic faujasite structure includ-
ing the alkali and alkaline earth groups of the periodic
table. In improvement (i), the formed zeolitic material
is catalytically deactivated by treatment with phosphates
by a process comprising the following steps

   a) mixing of at least one faujasite zeolite
powder, in particular a zeolite 13X powder or a zeolite
LSX powder, with a clay type binder, an inorganic phos-
phorous salt, water and, optionally, with an organic ad-
ditive

   b) production of a formed zeolitic body out
of the mixture of step a), and

   c) drying and calcination of said zeolitic
body produced in step b) to fix the binder and to get the
active adsorption reagent.

   The present invention also relates to a proc-
ess for purifying gas and liquid streams contaminated
with organic sulfur compounds which comprises passing
said gas and liquid feed streams over an adsorbent at a
temperature from about 10 to about 60°C and regenerating
said adsorbent in a gas flow at a temperature from about
150 to about 320°C, wherein the temperature profile of
the regeneration or desorption, respectively, is chosen
the way that a reduced amount of unremovable sulfur con-
taining side products compared to usual methods, i.e.
methods with fast heating to final "desorption" tempera-
ture, are generated.

   The desorption processes of the present in-
vention are in particular performed such that the desorp-
tion/regeneration is done by a heating profile allowing
the organic sulfur compounds to reach their equilibrium
adsorption capacity at each temperature.

   Such an equilibrium can be achieved at least
to an improved (or undesired side products reducing) ex-
tent if the desorption is done by fast heating to a basic

temperature of at most 200°C, preferably 100 to 150°C, in
particular about 150°C, and then using a temperature halt
at different temperature levels starting at the basic
temperature, or if the desorption is done by fast heating
5   to a basic temperature of at most 200°C, preferably 100
to 150°C, in particular about 150°C, and then heating us-
ing a small temperature increase rate at temperature lev-
els above the basic temperature.

10

Brief Description of the Drawings

Figure 1: A beaded molecular sieve 13X, fully
adsorbed with ethyl mercaptan, was desorbed in a TGA in-
15 strument, using a temperature increase of 5°C/min. This
experiment was carried out in ambient air. The curve
shows the weight loss (solid line) and the DSC curve
(dotted line).

Figure 2: A beaded molecular sieve 13X, fully
20 adsorbed with ethyl mercaptan, was desorbed in a TGA in-
strument, using a temperature increase of 5°C/min. The
carrier gas used for this experiment was purified nitro-
gen. The curve shows the weight loss (solid line) and the
DSC curve (dotted line).

25   **Figure 3:** A beaded molecular sieve 13X, deac-
tivated with phosphate, and fully adsorbed with ethyl
mercaptan, was desorbed in a TGA instrument, using a tem-
perature increase of 5°C/min. The carrier gas used for
this experiment was purified nitrogen. The curve shows
30 the weight loss (solid line) and the DSC curve (dotted
line).

Figure 4: A beaded molecular sieve 13X, not
deactivated with phosphate, but fully adsorbed with pro-
pyl mercaptan, was desorbed in a TGA instrument, using a
35 temperature increase of 5°C/min. up to 150°C. The halting
time at this temperature was 90 minutes. Higher tempera-
tures were achieved in time intervals of 30 minutes and

temperature intervals of 10°C. The carrier gas used for
this experiment was purified nitrogen. The curve shows
the weight loss (solid line) and the DSC curve (dotted
line), and the temperature profile (fine line).

5

Modes for Carrying out the Invention

Synthetic faujasites with silica to alumina
10 ratio of 1.9 : 1.0 to 3.0 : 1.0 have previously been de-
veloped for the adsorption of sulfur-contaminated com-
pounds from gas and liquid feed streams. In an attempt to
improve these conventional faujasites, the sodium cations
present have been substituted for by other metal ions
15 having larger size. However, contrary to the intended im-
provement, it was found that such substitutions generally
decrease the adsorption capacity of the faujasites for
sulfur-containing organic compounds. For example, it is
known that the potassium and calcium forms of faujasite X
20 type adsorbents are characterized by substantially lower
adsorption capacity for alkyl mercaptans and hydrogen
sulfide than the sodium form of the same faujasite X.
Nevertheless, zeolites in the calcium form, in particular
a formed zeolite that is between 60 and 95% in its cal-
25 cium form, and zeolites with high potassium content can
be used. All of these zeolites can be regenerated at ele-
vated temperatures, but all of them form substantial
amounts of oligomers and coke and thus lead to a decrease
of adsorption capacity for the forthcoming adsorption cy-
30 cles.
              The purification of a gas stream typically
occurs in a fixed bed of the adsorbent at temperatures
from about 10 to about 60°C, pressures from atmospheric
to about 12 Mpa (120 bars) and gas flow linear velocities
35 through the adsorbent bed from about 0.03 to about 0.35
m/sec. The thermal regeneration of the adsorbent, when
loaded with sulfur compounds, is performed in a purified

and dried gas flow at temperatures preferably from about
180 to about 320°C, the regeneration can occur shortly
after sulfur compound breakthrough of the adsorbent bed.

It has been surprisingly found that formation
5   of sulfur compound side products and thus deactivation of
the formed molecular sieve can be substantially decreased
by two independent but complementary process changes.

The first improvement being part of the in-
vention is dealing with the deactivation of the molecular
10   sieve to avoid formation of sulfur compound side prod-
ucts. Bronsted or Lewis acid sites on the formed molecu-
lar sieve are assumed to catalyze the transformation of
mercaptans into sulfides, disulfides, alkenes, etc. It
has now been found that adding a phosphate to the forming
15   process leads to a deactivation of the molecular sieve.
The phosphate leads to a masking of the catalytically ac-
tive centers in the clay binder and in the zeolite sys-
tem. The masking according to the invention has been
found to be strong enough to survive several adsorp-
20   tion/desorption cycles. Without wanting to be restricted
to a specific theory, it seems that the phosphate elimi-
nates to some extent the Bronsted and/or Lewis acid sites
in the molecular sieve.

A formed zeolite for adsorption purposes with
25   improved adsorption and desorption properties for sulfur
compounds can be produced by a process comprising the
following steps

a) mixing of at least one faujasite zeolite
powder, in particular a zeolite 13X powder or a zeolite
30   LSX powder, with a clay type binder, an inorganic phos-
phorous salt, water and, optionally, with an organic ad-
ditive

b) production of a formed zeolitic body out
of the mixture of step a), and
35   c) drying and calcination of said zeolitic
body produced in step b) to fix the binder and to get the
active adsorption reagent.

If desired, after step c) a step of ion ex-
change can be provided.

The zeolites used in step a), in particular
the zeolite 13X and/or LSX faujasites, can be produced
5   according to known methods, optionally followed by a step
of ion exchange.

The inorganic phosphorous salt used in step
a) usually is a water soluble phosphorous salt, prefera-
bly a salt selected from the group comprising tetrasodium
10 diphosphate, tetrasodium polyphosphate, trisodium phos-
phate, disodium hydrogen phosphate, sodium dihydrogen
phosphate, tripotassium phosphate, dipotassium hydrogen
phosphate, potassium dihydrogen phosphate or a mixture of
two or more of said salts.

15   The amount of inorganic phosphorous salt in
general is between 0.3 and 5.0 weight percent based on
the formed body weight, preferably between 0.3 and 3.0
weight percent based on the formed body weight.

The amount of clay binder usually is between
20 5 and 30 weight percent of the formed body weight, pref-
erably between 5 and 20 weight percent of the formed body
weight.

Although a zeolite that is between 60 and 95
% in its calcium form can be applied in the sulfur com-
25 pound adsorption process, it is preferred that the zeo-
lite is at least 70 % in its sodium form, preferably at
least 90%. Other exchangeable cations, such as alkaline
or alkaline earth cations, may be used before step a) to
produce a zeolite with the desired cation composition.
30 The zoelite is subjected to an ion exchange after the
usual preparation procedure. Alternatively, the ion ex-
change is done after step c) of the forming and calcina-
tion process to give the desired cation composition.

In step a)usually an organic additive such as
35 preferably a pore forming agent is added, in particular a
pore forming agent selected from the group consisting of
Rayon fibers, Nylon fibers, Sisal fibers and flax, as

well as organic polymers, such as starch, starch deriva-
tives, ligninsulfonates, polyacrylamides, polyacrylic ac-
ids, cellulose and cellulose derivatives.

5   The pore forming agent usually amounts to 2
to 15 weight percent based on the formed body weight.

        The use of zeolites obtainable according to
the method described above in conventional adsorp-
tion/desorption processes for the removal of sulfur com-
pounds, and in particular in adsorption/desorption proc-
10 esses that are also part of the present invention, are
further aspects of the present invention.

        A process applying such zeolites to remove by
adsorption one or more low molecular weight organic sul-
fur compounds from a gaseous or liquid stream, comprises
15 the step of passing the feed stream through a bed of
formed zeolitic molecular sieve obtainable according to
the present invention.

        Usually removed organic sulfur compounds are
one or more low molecular weight mercaptans or sulfides.
20   A preferred adsorption temperature is at most
60°C.

        The second improvement being part of the in-
vention is dealing with the regeneration of the molecular
sieve, again with the goal to suppress the formation of
25 sulfur compound side products, such as alkenes, sulfides,
disulfides, oligomers and coke.

        During the conventional thermal regeneration
process, a number of side products are formed that are
not easily desorbed from the molecular sieve. Especially
30 at higher temperatures, these products will undergo fur-
ther reactions and ultimately will lead to coke forma-
tion. For example, mercaptans are oxidized to sulfides,
disulfides and/or polysulfides. These newly formed sulfur
compounds are then adsorbed more strongly to the syn-
35 thetic faujasite, due to their higher molecular weight,
thereby reducing the adsorbent capacity of the faujasite.

TGA and DSC measurements revealed that the formation of side products takes place above 200°C. It has been surprisingly found that the degradation of the mercaptans can be reduced remarkably, if temperature in-
5   crease is done stepwise with a halt step at different levels. In one successful experiment, the temperature was increased in steps of 10°C at a time and the temperature was left unchanged for 30 minutes before it was increased by another 10°C. Using this approach, no exothermic reac-
10   tion could be observed, indicating that no degradation of the mercaptans took place.

To avoid the formation of side products of the sulfur compounds, in the inventive process that is applicable from low scale (i.e. gram scale) to large
15   scale, the regeneration temperature is not set at its maximum temperature from the very beginning, but - after having reached a basic temperature - is increased either stepwise or with a continuous temperature ramp with a slow increase in temperature. The temperature increase
20   should be performed such that the organic sulfur com- pounds reach their equilibrium adsorption capacity at each temperature. The regeneration agent used may be any non oxidizing gas such as natural gas, methane, ethane, nitrogen, hydrogen, or evaporated hydrocarbons.

25   In the desorption process of the present in- vention for the desorption of organic sulfur compounds from a formed faujasite zeolite, in particular formed zeolite 13X or formed zeolite LSX, or a mixture of formed zeolite 13X and formed zeolite LSX, the desorption is
30   done by fast heating to a basic temperature of at most 200°C, preferably 100 to 150°C, in particular about 150°C, and then using a temperature halt at different temperature levels starting at the basic temperature.

The halt time preferably is at least 10 min-
35   utes at each temperature level, and - also preferably - the temperature levels are at least 5°C and at most 50°C apart from each other.

In another procedure of the present inven-
tion, the desorption process of organic sulfur compounds
from a formed faujasite zeolite is done by fast heating
to a basic temperature of at most 200°C, preferably 100
5 to 150°C, in particular about 150°C, and then heating us-
ing a small temperature increase rate at temperature lev-
els above the basic temperature.

A preferred temperature increase rate is less
than 3°C/min. The maximum regeneration temperature pref-
10 erably is about 320°C.

It is also within the scope of the present
invention to apply a temperature profile with smaller
temperature increase rate than described above and
shorter halting times than described above such that an
15 average temperature increase rate similar to the tempera-
ture increase rate of the two above described procedures
results.

As already mentioned above, the preferred
zeolite for use in the inventive desorption methods is a
20 zeolite obtainable according to the deactivation method
described in the first aspect of the present invention.

In order to illustrate the present invention
and the advantages thereof, the following examples are
provided. It is understood that these examples are illus-
25 trative and do not provide any limitation on the inven-
tion.

Examples

30   **Example 1 (according to the invention)**

2250 g of zeolite 13X filter cake, obtained
from Zeochem AG, Uetikon, Switzerland, which had a mois-
ture content of 25%, was mixed with 320 g (dry base) of
an attapulgite binder and 25 g of tetrasodium diphos-
35 phate. This mixture was moistened further with water and
mixed in a laboratory scale Eirich mixer R02 to get zeo-
lite beads. The green beads were sieved to a fraction of

1.6 - 2.6 mm, dried at 100°C and then calcined at 620°C
for one hour. The calcined material was cooled to room
temperature and then stored in an air tight container.

5   **Example 2 (prior art)**
           A sample of about 2 g of commercially avail-
able beaded molecular sieve 13X (Zeochem AG, Uetikon,
Switzerland; brand name molecular sieve Z10-03) was put
in a desiccator and loaded with ethyl mercaptan at a tem-
10 perature of 25°C. The fully loaded molecular sieve was
put in a small alumina crucible of a TGA instrument and
the temperature programmed desorption was recorded. At
the same time the energy flow was determined and the DSC
curve recorded.

15   The desorption was done under ambient air and
with a temperature increase of 5°C/min. A strong exother-
mic reaction was observed at about 225°C, indicating that
the mercaptan undergoes a degradation reaction. The re-
sult is also shown in Figure 1.

20

           Example 3 (prior art)
           As example 2, but the desorption was done
with nitrogen as a desorption gas and with a temperature
increase of 5°C/min. An exothermic reaction was observed
25 at 220 - 250°C. The result is also shown in Figure 2.

           Example 4 (according to the invention)
           A sample of about 2 g of the zeolite synthe-
sized in example 1 was put in a desiccator and loaded
30 with ethyl mercaptan at a temperature of 25°C. The fully
loaded molecular sieve was put in a small alumina cruci-
ble of a TGA instrument and the temperature programmed
desorption was recorded. At the same time the energy flow
was determined and the DSC curve recorded.

35   The desorption was done with nitrogen as a
desorption gas and with a temperature increase of
5°C/min. No exothermic reaction was observed over the

whole temperature range of desorption. The result is also shown in figure 3.

Example 5 (according to the invention)

5   A sample of about 2 g of commercially available beaded molecular sieve 13X (Zeochem AG, Uetikon, Switzerland; brand name molecular sieve Z10-03) was put in a desiccator and loaded with propyl mercaptan at a temperature of 25°C. The fully loaded molecular sieve was

10   put in a small alumina crucible of a TGA instrument and the temperature programmed desorption was recorded. At the same time the energy flow was determined and the DSC curve recorded.

        The desorption was done with nitrogen as a

15   desorption gas. Up to 150°C, the heating was done at a pace of 5°C/min., then a halting time of 90 min. was introduced. After that, the heating was done stepwise with temperature increases of 10°C and a halting time of 30 min. at each temperature. The desorption of propyl mer-

20   captan went very smoothly, and no exothermic reaction was observed. The result is also shown in Figure 4.

        While there are shown and described presently preferred embodiments of the invention, it is to be dis-

25   tinctly understood that the invention is not limited thereto but may be otherwise variously embodied and practiced within the scope of the following claims.

16

Claims

1. A process to produce a formed zeolite for adsorption purposes with improved adsorption and desorption properties comprising the following steps

a) mixing of at least one faujasite zeolite powder, in particular a zeolite 13X powder or a zeolite LSX powder, with a clay type binder, an inorganic phosphorous salt, water and, optionally, with an organic additive

b) production of a formed zeolitic body out of the mixture of step a), and

c) drying and calcination of said zeolitic body produced in step b) to fix the binder and to get the active adsorption reagent.

2. The process of claim 1, comprising after step c) a step of ion exchange.

3. The process of anyone of the preceding claims, wherein the amount of clay binder is between 5 and 30 weight percent of the formed body weight.

4. The process of anyone of the preceding claims, wherein the amount of clay binder is between 5 and 20 weight percent of the formed body weight.

5. The process of anyone of the preceding claims, wherein the zeolite powder is at least 70 % in its sodium form.

6. The process of anyone of the preceding claims, wherein the zeolite powder is at least 90% in its sodium form.

7. The process of anyone of the preceding claims, wherein the zeolite powder is at maximum 30 % in its potassium form.

8. The process of anyone of the preceding claims, wherein a pore forming agent is added to the zeolite and binder mixture, in particular a pore forming agent selected from the group consisting of Rayon fibers, Nylon fibers, Sisal fibers and flax, as well as organic

polymers, such as starch, starch derivatives, ligninsul-
fonates, polyacrylamides, polyacrylic acids, cellulose
and cellulose derivatives.

9. The process of anyone of the preceding
claims, wherein the pore forming agent amounts to 2 to 15
weight percent based on the formed body weight.

10. The process of anyone of the preceding
claims, wherein the inorganic phosphorous salt used in
step b) is a water soluble phosphorous salt, in particu-
lar a phosphorous salt selected from the group consisting
of tetrasodium diphosphate, tetrasodium polyphosphate,
trisodium phosphate, disodium hydrogen phosphate, sodium
dihydrogen phosphate, tripotassium phosphate, dipotassium
hydrogen phosphate, potassium dihydrogen phosphate or a
mixture of two or more of said phosphorous salts.

11. The process of anyone of the preceding
claims, where the amount of inorganic phosphorous salt is
between 0.3 and 5.0 weight percent based on the formed
body weight.

12. The process of anyone of the preceding
claims, where the amount of inorganic phosphorous salt is
between 0.3 and 3.0 weight percent based on the formed
body weight.

13. A zeolitic adsorption compound obtainable
according to the process of anyone of the preceding
claims.

14. A process to remove by adsorption one or
more low molecular weight organic sulfur compounds from a
gaseous or liquid stream, wherein the feed stream is
passed through a bed of formed zeolitic molecular sieve
according to claim 13.

15. The process of claim 14, wherein the or-
ganic sulfur compounds are one or more low molecular
weight mercaptans or sulfides.

16. The process of claim 14 or 15, wherein
the adsorption temperature is at most 60°C.

17. A desorption process for the desorption of organic sulfur compounds from a formed faujasite zeolite, in particular formed zeolite 13X or formed zeolite LSX, or a mixture of formed zeolite 13X and formed zeo-
5 lite LSX, wherein the desorption is done by a heating profile allowing the organic sulfur compounds to reach their equilibrium adsorption capacity at each temperature.

18. A desorption process, in particular ac-
10 cording to claim 17, for the desorption of organic sulfur compounds from a formed faujasite zeolite, in particular formed zeolite 13X or formed zeolite LSX, or a mixture of formed zeolite 13X and formed zeolite LSX, wherein the desorption is done by fast heating to a basic temperature
15 of at most 200°C, preferably 100 to 150°C, in particular about 150°C, and then using a temperature halt at different temperature levels starting at the basic temperature.

19. A process according to claim 18, wherein the halt time is at least 10 minutes at each temperature
20 level.

20. A process according to claim 18 or 19, wherein the temperature levels are at least 5°C and at most 50°C apart from each other.

21. A desorption process, in particular ac-
25 cording to claim 17, of organic sulfur compounds from a formed faujasite zeolite, in particular a formed zeolite 13X or formed zeolite LSX, or a mixture of formed zeolite 13X and LSX, wherein the desorption is done by fast heating to a basic temperature of at most 200°C, preferably
30 100 to 150°C, in particular about 150°C, and then heating using a small temperature increase rate at temperature levels above the basic temperature.

22. A process of claim 21, wherein the temperature increase rate is less than 3°C/min.
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23. The process of anyone of claims 17 to 22, wherein the zeolite is a zeolite of claim 13.

24. The process of anyone of claims 17 to 23, wherein the maximum regeneration temperature is about 320°C.

25. The process of anyone of claims 17 to 24, wherein the regeneration gas is a dry natural gas, methane, natural gas liquids, hydrogen, nitrogen or hydrocarbons.

Fig. 1

Fig. 2

Fig. 3

Fig. 4